Chem 321

Module 14: Calculation of the Buffer pH Using Activities

Buffer solution: mix 100 mL of 0.030 M KH_2PO_4 + 100 mL of 0.050 M K_2HPO_4

Solution

Since equal volumes of the solutions are mixed, the resulting concentration of each salt is just one-half of its starting concentration.

$[H_2PO_4^-]$ = 0.015 M, $[HPO_4^{2-}]$ = 0.025 M and $[K^+]$ = 0.015 M + 0.050 M = 0.065 M

the ionic strength $\mu = \frac{1}{2}[(0.015\ M)(-1)^2 + (0.025\ M)(-2)^2 + (0.065\ M)(+1)^2] = 0.090\ M$

for μ = 0.90 M,

$$\gamma_{H_2PO_4^-} = 0.82 - \frac{0.090 - 0.050}{0.050}(0.82 - 0.775) = 0.78_4$$

$$\gamma_{HPO_4^{2-}} = 0.445 - \frac{0.090 - 0.050}{0.050}(0.445 - 0.355) = 0.373$$

	$H_2PO_4^-$	+ H_2O	⇆ H_3O^+	+ HPO_4^{2-}
init	0.015 M		~10^{-7} M	0.025 M
equil	~0.015		x	~0.025

$$K_a = 6.3\,x\,10^{-8} = \frac{a_{H_3O^+}a_{HPO_4^{2-}}}{a_{H_2PO_4^-}} = \frac{a_{H_3O^+}[HPO_4^{2-}]\gamma_{HPO_4^{2-}}}{[H_2PO_4^-]\gamma_{H_2PO_4^-}} = \frac{a_{H_3O^+}(0.025)(0.373)}{(0.015)(0.78_4)}$$

$a_{H3O+} = 7.9_5 \times 10^{-8} \quad \Rightarrow \quad pH = -\log(a_{H3O+}) = \mathbf{7.10}$